Calendar Year 2003-2005 California Red-legged Frog (*Rana draytonii*) Surveys, Golden Gate National Recreation Area

Horse Stable Pond, January 6, 2006

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ABSTRACT

This report summarizes field activities that have occurred over the past three years: Winter 2003-2004, Winter 2004-2005, and Winter 2005-2006 for winter breeding amphibians and summer trapping within the legislative boundary of the Golden Gate National Recreation Area. Egg mass surveys were conducted for the threatened California red-legged frog (*Rana draytonii*). Areas surveyed for egg masses included Big Lagoon, Milagra Ridge, Mori Point and Sharp Park. Additional sites were surveyed during this period by contractors to the GGNRA. California red-legged frog egg masses were present at three sites. Trapping activities documented presence of California red-legged frog tadpoles in Olema Creek near Point Reyes Station and Rodeo Lake.

INTRODUCTION

This report summarizes field activities that occurred over the past three winters, Winter 2003-2004, Winter 2004-2005, and Winter 2005-2006, for winter-breeding frogs in select wetlands and aquatic sites within the legislative boundary of the Golden Gate National Recreation Area. Survey activities focused mainly on the threatened California red-legged frog (*Rana draytonii*). Egg mass surveys were intended to provide long-term monitoring data to assess trends in abundance of winter-breeding frogs, specifically the California red-legged frog at sites within Marin and San Mateo Counties. Monitoring of known red-legged frog populations would be consistent with identified recovery plan tasks (USFWS 2002). In addition, trapping surveys were conducted at a couple sites to determine the presence of amphibian larvae.

METHODS

Egg Mass Surveys

Egg mass surveys were conducted from early to late-winter targeting California red-legged frogs. Initiation of survey activities started once seasonal ponds retained surface water. Surveys are conducted during daylight hours and on days where water clarity allowed the surveyor to see red-legged frog egg masses. Most surveys were conducted on foot, except at Rodeo Lagoon/Lake which was surveyed using an inflatable kayak because of soft sediments.

The surveyor typically recorded event-based data including duration of survey, general weather conditions, water clarity, water temperature, and general information about the extent of surveys. Species-specific data included species and number of egg masses (or abundance categories for Pacific tree frog egg masses). Specific to red-legged frogs, we recorded Gosner life stage, approximate volume of egg masses, attachment type, water depth at egg mass, and location of egg mass relative to water surface. Flagging was used to mark vegetation near egg masses to avoid repeat counts in subsequent surveys. For large water-bodies (e.g., Horse Stable Pond/Laguna Salada), the location of egg masses were recorded on paper maps in the field. Red-legged frog egg mass survey data since 2001 have been placed in a Microsoft Access database. A summary of survey conditions and sample dates for egg masses is provided in Table 2.

Trapping Surveys

Collapsible minnow traps were deployed at various wetland sites in the summer to document the presence of larval amphibians. Traps were typically deployed in the morning and then retrieved in the afternoon to prevent mortality of trapped individuals due to oxygen depletion at night. Also, smolt traps were operated on Olema, Pine Gulch and Redwood Creeks (Marin Co.) during the late spring to document the movement of aquatic animals, particularly salmonid smolts that are leaving for the Pacific Ocean. A summary of trapping activities is provided in

Table 6. Trapping activities were done at Olema Creek, Pine Gulch Creek, Redwood Creek, Rodeo Lake, and Big Lagoon.

Study Area

Detailed descriptions of the study areas and location maps are provided in Appendix I. Sites were chosen for egg mass surveys based on past information regarding the presence of juvenile or adult red-legged frogs. At Big Lagoon, surveys efforts focused on past locations where eggs were found by U.S. Geological Survey-Biological Resources Division (Fellers and Guscio 2004) and Park staff (Fong 2000). At Mori Point, surveys focused on two ponds that were created in November 2004. No surveys were conducted along adjacent Sanchez Creek. This creek is heavily shaded. At Sharp Park, egg mass surveys focused on predominantly freshwater Horse Stable Pond with infrequent surveys of the more saline Laguna Salada based on past red-legged frog breeding activity (Fong 2000). As in past years, surveys at Milagra Ridge were conducted at the oxidation pond. No surveys were conducted along Milagra Creek. Although perennial streamflow is present, past stream surveys for fish indicate an entrenched, heavily shaded and steep gradient channel. It is unlikely that breeding would occur in the creek under these conditions.

RESULTS

Egg Mass Surveys

Egg mass surveys indicated the presence of California red-legged frog breeding activity at Sharp Park/Mori Point complex, Milagra Ridge, and Rodeo Lagoon/Lake complex (Tables 3,5). The numbers of red-legged frog egg masses were generally similar by site for the three years of surveys (Table 3). Small numbers of red-legged frog egg masses were counted in Rodeo Lake in Winter 2004-2005 and 2005-2006, although none were observed in the adjacent Rodeo Lagoon. Milagra Ridge had egg mass counts from 31-40 for the three years (Table 3).

There were a few sampling issues that bear mentioning because they may ihave nfluenced the actual number of observed eggs. The Laguna Salada/Mori Point sites had the highest numbers of counted eggs; the low numbers observed in Winter 2004-2005 may be due to the late initiation of surveys (February 11, 2005). In Winter 2005-2006, persistent late February-March rains made it difficult to conduct egg mass surveys due to turbid water conditions. There was a month gap between surveys from late February and late March. It is possible that eggs lain in early March may have been obscured by algae or silt and not observable. Past survey years have indicated egg laying activities in early March.

Surveys conducted at Big Lagoon in lower Redwood Creek in Winter 2002-2003 by USGS identified small numbers of egg masses (Fellers and Guscio 2004). However, subsequent surveys by our contractor in Winter 2003-2004 (Wood 2004), park staff in Winter 2004-2005, and contractor in Winter 2005-2006 failed to confirm successful breeding activity. Fellers and Guscio (2004) noted that flood control activities conducted by NPS reduced the ability of the seasonal wetland to pond water of sufficient duration and extent to maintain satisfactory habitat for the development and metamorphosis of red-legged frog tadpoles.

During a January 6, 2006 egg mass survey at Mori Point (Laguna Salada watershed), one of the created ponds near Sanchez Creek (ID# LS05) had a red-legged frog tadpole swimming in the water (5 cm TL). The tadpole at that point still did not have developed limbs. This shaded pond retained water throughout the past year. It is likely that this individual was from an egg laid in Winter 2004-2005.

Egg mass surveys documented the occurrence of stranded egg masses at both Milagra Ridge Oxidation Pond and Horse Stable Pond (Laguna Salada) (San Mateo County). While the Milagra Ridge Oxidation Pond had eggs that were stranded, many of the stranded eggs were still partially in the water. On the other hand, many of the stranded egg masses at Horse Stable Pond were fully out of water and entirely desiccated (Figures 1-2). Surveys in Winter 2003-2004 and 2004-2005 found red-legged frog egg masses that were fully stranded at Horse Stable Pond (Table 4). In 2004, 14 of the 35 egg masses were stranded while in 2005, 7 of the 16 egg masses were stranded. These strandings occurred as a result of pumping activities intended to reduce water levels in Horse Stable Pond to keep the adjacent golf course greens dry (See Appendix I, Sharp park/Mori Point Site Description).

Trapping Surveys

Rodeo Lake. Pairs of collapsible minnow traps were placed three locations along the southern shoreline of Rodeo Lake in June 28, 2005 (0800-1600 PST) (Figure 3). The highest abundances of red-legged frog tadpoles were at the far southwest trap site (Trap Site 1, 10 tadpoles) while none were found at the furthest southeast site. This information corresponds with the location of the egg masses found by Leslie Wood on the western side of Rodeo Lake (Wood 2005).

Big Lagoon. Trapping at Big Lagoon was only conducted on a single date at a single location using 3 traps (Table 6). As with egg mass surveys conducted that winter, no red-legged frog tadpoles were collected.

Olema Creek. Large numbers of red-legged frog tadpoles were captured at the Olema Creek smolt trap above the confluence with Lagunitas Creek in Spring 2005. The smolt trap is downstream of where mainstem Olema Creek had recently avulsed into an adjacent pasture. Stream flows have dispersed over a

broader area resulting in development of slow water areas and emergent vegetation. It is likely that this developing wetland area supports breeding habitat for red-legged frogs. A single red-legged frog tadpole was also captured in the Pine Gulch smolt trap. It is unclear whether this individual was washed into the creek from an adjacent breeding site or was from instream breeding activities.

Mortality/Injury

Mortality and injury was associated with many of the California red-legged frog tadpoles that were captured in the Olema Creek trap. Upon recognizing this occurrence, operation of the smolt trap on Olema Creek ceased and the structure removed. The incident was reported to U.S. Fish and Wildlife staff and measures to prevent this event from re-occurring implemented (email to Don Hankins on May 11, 2005).

Water level

Many of our breeding locations for California red-legged frogs are seasonal wetlands. Visits are made infrequently throughout the summer to document the persistence of water. During drought years many of the seasonal wetlands may have little or no red-legged frog production. For example, the Milagra Ridge Pond was dry by June 7, 2000. It is unlikely that very many tadpoles had metamorphosed. Table 7 lists the dates when seasonal wetlands had gone dry.

DISCUSSION

Rodeo Lagoon watershed

Rodeo Lake appears to be the main destination for red-legged frog breeding purposes. On a rainy Dec 30, 2004 night, a road-killed adult female red-legged frog was collected on Bunker Road, where it bisects both the lagoon and the lake. In addition, a live adult frog was captured at this same location just a few weeks later. A third frog that was on the road on a rainy winter night was also captured and moved out of harm's way. No breeding activity has been documented elsewhere in the watershed.

No California red-legged frog egg masses were observed in Rodeo Lagoon despite juvenile frogs being found along the eastern perimeter in Fall 2005. There are some characteristics of the lagoon that make it less desirable as breeding habitat when compared to Rodeo Lake. First, Rodeo Lake has a well developed mat of submergent vegetation that rings the entire perimeter comprised mainly of *Hydrocotyle* sp (Appendix I-Rodeo Lake/Lagoon Site Description, Wood 2005). All observed egg masses in 2004-2005 were attached to submergent vegetation in this area (Wood 2005). Although mats of submergent vegetation such as *Potamogeton* may be present in the summer in

the eastern end of the lagoon, they are usually absent by winter. Furthermore, Rodeo Lagoon has only a narrow band of tall, emergent vegetation (e.g., cattails and tules) for cover along the shoreline. Also, winter water level fluctuations in Rodeo Lagoon may also make it less attractive for frogs. For example, in the winter 2004, a series of natural breach and drain events changed water levels quickly in the lagoon, generally on order of 2-3 feet in less than a week (Figure 4, Shaw 2005). When this happens, cover and egg attachment sites such as the emergent vegetation are left high and dry. Conversely, water level fluctuations in Rodeo Lake are attenuated by an artificial weir that separates it from the adjacent lagoon. Based on the literature, salinity levels during the winter do not appear to be an issue for egg and tadpole survival. The recovery plan cites studies where 100% egg mortality occurs at levels greater than 4.5 ppt and mortality to tadpoles at levels greater than 7 ppt (FWS 2002). Even when the lagoon mouth is open to the ocean, surface salinity levels near the end of the lagoon at the freshwater input have been less than 0.5 parts per thousand (Table 8).

The Park has developed a transportation plan for the Marin Headlands and mitigation measures are proposed to reduce the incidence of road kills along Bunker Road. Not only are California red-legged frogs hit by vehicles, but California newts as well. Proposed mitigation measures include an awareness program for Park staff and other workers at Fort Cronkhite, amphibian undercrossings at key sites along the road, and seasonal signage.

TABLES

Table 1: Location ID codes and geographic coordinates (UTM, NAD83, Zone 10) for California red-legged frog sampling sites, Golden Gate National Recreation Area.

LocationID	Description	Watershed	County	StartUTMX	StartUTMY	StopUTMX	StopUTMY
LS01	Horse Stable Pond	Laguna Salada	San Mateo	544585	4163952		
LS02	Laguna Salada Northwest shoreline	Laguna Salada	San Mateo	544717	4164515		
LS03	Laguna Salada Southwest shoreline	Laguna Salada	San Mateo	544703	4164304		
LS04	Horse Stable Pond Slough	Laguna Salada	San Mateo	544631	4163959	544698	4164018
LS05	Mori Point Pond 'A' nr Sanchez Creek	Laguna Salada	San Mateo	544796	4163900		
LS06	Mori Point Pond 'D' @ Mori's Pt Road	Laguna Salada	San Mateo	544794	4163803		
LS07	Mori Point Ponds south of Mori's Pt Road	Laguna Salada	San Mateo	544827	4163764		
MC01	Milagra Ridge Oxid. Pond	Milagra Creek	San Mateo	546584	4165889		
RC01	Big Lagoon Environs @ Green Gulch weir	Redwood Creek	Marin	537468	4190482		
RC02	Big Lagoon Environs @ GG wetland	Redwood Creek	Marin	537472	4190519	537472	4190588
RC03	Big Lagoon Environs @ GG xditch	Redwood Creek	Marin	537473	4190651	537463	4190676
RC04	Big Lagoon Environs @ former picnic area	Redwood creek	Marin	537366	4190441		
RC05	Big Lagoon Environs @ RW creek backwater	Redwood Creek	Marin	537468	4190482	537396	4190706
RL01	Gerbode Creek Wetland	Rodeo Lagoon	Marin	542375	4187663		
RL02	Rodeo Lake	Rodeo Lagoon	Marin	541789	4187306		
RL03	Lower Rodeo Creek @ Rodeo Lake	Rodeo Lagoon	Marin	541916	4187281		
RL04	Rodeo Lagoon-East shore	Rodeo Lagoon	Marin	541445	4187262	541467	4187130
RL05	Rodeo Lagoon-various	Rodeo Lagoon	Marin				
SM01	Sweeney Ridge-South Meadow	San Mateo Creek	San Mateo	548668	4160679		
SP01	Sweeney Ridge-Discovery Site	San Pedro Creek	San Mateo	548080	4161775		
TV01	Tennessee Valley Haypress Pond	Tennessee Valley	Marin	539961	4190655		
TV02	Tennessee Valley Cove Pond	Tennessee Valley	Marin	539625	4188647		
TV03	Backdoor Pond	Tennessee Valley	Marin	540930	4189176		
TV04	Tennessee Valley Creek (Elk Crk)	Tennessee Valley	Marin	539738	4188828	540577	4189305
TV05	Tennessee Valley Cove Marsh	Tennessee Valley	Marin	539624	4188684		

Table 2: Summary of event data for amphibian winter breeding surveys at Golden Gate National Recreation Area for Winter 2003-2004, 2004-2005, 2005-2006.

BREEDING YEAR	LOCATIONID	Date	Start Time (PST)	SURVEY TIME (MIN)	OBSV1	OBSV2	Weather	Wind*	AirTemp (°C)	Water Temp (°C)	Water Vis (m)
2004	LS01	12/18/2003	11:50	40	JC	DF	Clear	1			
2004	LS01	1/9/2004	8:45	20	JC	RZ	Overcast	3	14		
2004	LS01	2/6/2004	9:00	60	JC	DF	Pt. Cloudy	0	12.1	10.7	
2004	LS01	3/5/2004	9:00	90	JC	CT	Overcast	3	16	10	
2005	LS01	2/11/2005	8:30	60	JC	RZ	Overcast		16.1		
2005	LS01	3/1/2005	12:10	30	JC	DF	Clear		22.2	13.9	0.4
2005	LS01	3/5/2005	15:35	30	JC		Clear	0	21		
2005	LS01	3/9/2005	16:15	30	JC		Clear	0			
2005	LS01	3/30/2005	14:50	20	DF	JC	Clear	0	18.6	15	0.35
2006	LS01	12/23/2005	8:15	30	JC		Overcast	0	14.4		
2006	LS01	1/6/2006	9:20	60	JC	DF	Pt. Cloudy	0	17.7		
2006	LS01	1/25/2006	8:45	90	JC	DF	Pt. Cloudy	0	13.3		
2006	LS01	2/8/2006	9:48	60	JC		Clear	4	20.5		
2006	LS01	2/16/2006	8:30		L	DF	Clear	0			
2006	LS01	3/20/2006	8:30	30	JC	DF	Rain	0	7.7		
2006	LS03	1/25/2006	10:45	30	JC		Pt. Cloudy	0	13.3		
2004	LS05	1/16/2004	11:00	5	DF		Overcast	2			
2004	LS05	2/6/2004	10:30	15	DF		Clear	2		8.2	
2004	LS05	3/3/2004	9:45	5	EM	JR	Clear	2	16		
2005	LS05	12/20/2004	9:30	5	DF		Clear	0	12	8.5	
2005	LS05	1/14/2005	15:40	5	DF	EM	Clear	2			
2005	LS05	2/2/2005	15:35	8	DF	EM	Clear	2	17	14.6	
2005	LS05	3/1/2005	13:10	5	DF		Clear			16	
2005	LS05	3/30/2005	15:31	12	DF		Clear			19	0.55
2006	LS05	12/11/2005	12:05	7	DF		Clear	2	18.5	12.5	0.3
2006	LS05	1/6/2006	10:10	20	DF		Clear	0		10	
2006	LS05	1/25/2006	9:49		DF		Clear	0	17	8	0.95

BREEDING YEAR	LOCATIONID	Date	Start Time (PST)	SURVEY TIME (MIN)	OBSV1	OBSV2	Weather	Wind*	AirTemp (°C)	Water Temp (°C)	Water Vis (m)
2006	LS05	2/16/2006	9:48		DF	CC	Clear	0	14	7	1
2006	LS05	3/20/2006	9:00	9	DF		Rain	2	13	11.5	
2005	LS06	12/20/2004	9:40	2	DF		Clear	0	14		0.5
2005	LS06	1/14/2005	16:00	3	EM		Clear	2		9.4	
2005	LS06	2/2/2005	15:25	2	DF	EM	Clear	2	17	14.4	
2005	LS06	3/1/2005	13:05	2	DF		Clear			14	
2005	LS06	3/30/2005	15:27	3	DF		Clear		18	19	0.3
2006	LS06	12/11/2005	12:00	0	DF		Clear				
2006	LS06	1/6/2006	10:05	10	DF		Clear	0		12	0.2
2006	LS06	1/25/2006	9:15	10	DF		Clear	0	15	10	0.2
2006	LS06	2/16/2006	9:30	10	DF		Clear	0	13		
2006	LS06	3/20/2006	8:45	3	DF		Rain	2	13	10	0.3
2004	LS07	1/16/2004	10:45	5	EM	DF	Overcast	2			
2004	LS07	2/6/2004	10:05	5	DF		Clear	0		10.7	
2004	LS07	3/3/2004	9:30		EM	JR	Clear	4	16		
2005	LS07	3/1/2005	13:10		DF		Clear				
2005	LS07	3/30/2005	15:48		DF		Clear				
2006	LS07	12/11/2005	12:00	0	DF		Clear				
2006	LS07	1/6/2006	9:50	10	DF		Clear				0.4
2006	LS07	1/25/2006	9:45	5	DF		Clear	0	15	11.5	0.1
2006	LS07	2/16/2006	9:40	1	DF		Clear	0			
2006	LS07	3/20/2006	8:50	5	DF		Rain	2	13		0.5
2004	MC01	12/18/2003	13:55	14	DF		Clear	2	20	9	
2004	MC01	1/16/2004	8:55	65	DF	EM	Overcast	4	9.6	9.2	0.4
2004	MC01	2/6/2004	11:30	40	DF		Pt. Cloudy	0	12.4	11.1	0.5
2004	MC01	3/3/2004	8:30	34	DF	EM	Clear	2	16	11	0.35
2004	MC01	3/30/2004	9:45	40	DF		Rain	4	11.7	12.5	0.45
2005	MC01	12/20/2004	10:25	40	DF		Overcast	2	8	9	
2005	MC01	1/14/2005	14:50	20	DF	EM	Clear	2	15.1	7.5	
2005	MC01	2/2/2005	16:05	55	DF	EM	Clear	2		13.9	0.3

BREEDING YEAR	LOCATIONID	Date	Start Time (PST)	SURVEY TIME (MIN)	OBSV1	OBSV2	Weather	Wind*	AirTemp (°C)	Water Temp (°C)	Water Vis (m)
2005	MC01	2/23/2005	15:20	45	DF	KD	Overcast		13.2	12.1	0.2
2005	MC01	3/30/2005	16:15	15	DF		Clear			19	0.25
2006	MC01	12/11/2005	12:45	0	DF		Clear				
2006	MC01	1/6/2006	11:10	45	DF		Clear	2		11.5	0.25
2006	MC01	1/25/2006	10:38	55	DF		Overcast	2			0.3
2006	MC01	2/16/2006	10:26	37	DF		Clear	0			0.5
2006	MC01	3/20/2006	9:38	12	DF		Rain	2		9	
2005	RC01	12/17/2004	14:50		DF		Clear		17.8	12.4	
2005	RC01	1/6/2005	14:00	30	DF		Clear		12.9	11.1	0.5
2006	RC01	1/25/2005	10:30	27	DF		Rain	2	13.9	9.4	0.5
2005	RC01	2/23/2005	11:10	25	DF		Overcast		13.9	11.5	0.4
2005	RC01	3/17/2005	16:20	23	DF	CS	Overcast		12.4	12.7	0.6
2004	RC02	1/6/2004	16:00	30	LW		Overcast	0	11	10	
2004	RC02	1/20/2004	11:00	75	LW		Clear	1	8	10	
2004	RC02	2/18/2004	10:25	70	LW		Pt. Cloudy	1	17	10	
2004	RC02	3/17/2004	11:20	70	LW		Clear	1	24	15	
2004	RC02	4/2/2004	11:50	50	LW		Clear	1	20	16	
2005	RC02	12/17/2004	14:50		DF		Clear				
2005	RC02	1/6/2005	14:30	34	DF		Clear			10.1	
2005	RC02	1/25/2005	11:00	29	DF		Overcast	2	13.9	9.8	
2005	RC02	2/25/2005	11:40	23	DF		Overcast		13.9	11.8	
2005	RC02	3/17/2005	16:50	24	DF	CS	Overcast		13.1		
2005	RC03	12/17/2004	14:50		DF		Clear				
2005	RC03	1/6/2005	15:15	18	DF		Clear				
2005	RC03	1/25/2005	11:39	10	DF		Overcast	2	13.9	9.1	
2005	RC03	2/25/2005	12:05	5	DF		Overcast		13.9	11.7	
2005	RC03	3/17/2005	17:20	7	DF	CS	Overcast				
2005	RC04	3/17/2005	17:40		DF		Overcast				
2005	RC05	1/25/2005	11:55	7	DF		Overcast	2	13.9	8.6	
2005	RL02	12/20/2004	13:25	45	LW		Overcast	4	11	9	

BREEDING YEAR	LOCATIONID	Date	Start Time (PST)	SURVEY TIME (MIN)	OBSV1	OBSV2	Weather	Wind*	AirTemp (°C)	Water Temp (°C)	Water Vis (m)
2005	RL02	1/12/2005	14:55	35	LW		Clear	2	12	9	
2005	RL02	1/26/2005	18:30	39	LW		Mostly Cloudy	2	13	11	
2005	RL02	1/28/2005	11:50	60	LW		Clear	4	14	12	
2005	RL02	2/16/2005	15:00	35	LW		Mostly Cloudy	2	18	13	
2005	RL02	3/9/2005	14:30	50	LW		Clear	4	18	14	
2006	RL02	1/5/2006	16:00	49	DF		Clear	3			1.2
2006	RL02	3/27/2006	9:23	28	DF		Clear	0		11	0.25
2006	RL04	1/9/2006	15:50	40	DF		Clear	2			0.2
2006	RL04	2/14/2006	10:35	40	DF		Clear	0			0.5
2006	RL04	3/27/2006	10:05	35	DF		Clear	2		15	
2006	RL05	1/26/2005	18:40	30	LW		Mostly Cloudy	2	13		
2005	RL05	1/28/2005	13:00	25	LW		Clear	4	14		
2005	RL05	2/16/2005	19:45	25	LW		Overcast	2	14		
2005	RL05	3/9/2005	20:05	25	LW		Clear	1	13		
2005	SM01	12/15/2004	14:00	5	DF	KS	Clear	0			
2005	SP01	12/15/2004	14:00	5	DF	BM	Clear	0			
2005	TV02	12/20/2004	11:30	52	LW		Overcast	4	9	9	
2005	TV02	1/5/2005	18:28	35	LW		Pt. Cloudy	4	8	10	
2005	TV02	1/12/2005	10:55	48	LW		Clear	2	12	10	
2005	TV02	1/26/2005	21:00	20	LW		Mostly Cloudy	2	10	10	
2005	TV02	1/28/2005	14:15	30	LW		Pt. Cloudy	6	13	12	
2005	TV02	2/16/2005	12:30	55	LW	MG	Overcast	4	18	12	
2005	TV02	3/9/2005	12:30	40	LW		Clear	4	18	14	
2005	TV04	11/30/2004	10:45	70	LW		Clear	2	11	6	
2005	TV04	12/8/2004	13:00	65	LW		Overcast	2			
2005	TV05	1/12/2005	12:30	30	LW		Clear	2	12	10	
2005	TV05	1/28/2005	15:02	18	LW		Pt. Cloudy	2	13	12	

*Beaufort Wind Categories: (0) no wind, (1) 1-3 mph, (2) 4-7 mph, (3) 8-12 mpg, (4) 13-18 mph, (5) 19-24 mph, (6) >25 mph

Table 3: Summary of California red-legged frog egg mass counts by watershed and breeding year.

Watershed	Breeding Year	Egg Masses
Laguna Salada	2004	55
Laguna Salada	2005	19
Laguna Salada	2006	57
Milagra Creek	2004	40
Milagra Creek	2005	39
Milagra Creek	2006	31
Redwood Creek	2004	0*
Redwood Creek	2005	0
Redwood Creek	2006	0*
Rodeo Lagoon	2005	4
Rodeo Lagoon	2006	5*

*Surveys conducted and reported separately by contractor (Leslie Wood)

Table 4: Summary of partly stranded and stranded California red-legged frog egg masses at Laguna Salada and Milagra Creek watershed sites by breeding year.

Breeding Year	LocationID	Date	Egg Masses
2004	LS01	2/6/2004	5
2004	LS01	3/5/2004	9
2005	LS01	2/11/2005	7
2005	MC01	12/20/2004	3
2005	MC01	2/2/2005	5
2006	MC01	1/6/2006	9
2006	MC01	1/25/2006	2

Table 5: Summary of egg mass counts by species, watershed and breeding year.

Breeding Year	LocationID	Date	Egg Masses	Egg Mass Categories	SpeciesID
2004	LS01	2/6/2004	35		RADR
2004	LS01	3/5/2004	20		RADR
2005	LS01	2/11/2005	8		RADR
2005	LS01	3/1/2005	6		RADR
2005	LS01	3/5/2005	1		RADR
2005	LS01	3/9/2005	1		RADR
2006	LS01	1/6/2006	8		RADR
2006	LS01	1/25/2006	33		RADR
2006	LS01	2/8/2006	1		RADR
2006	LS01	2/16/2006	1		RADR
2006	LS03	1/25/2006	2		RADR
2004	LS05	2/6/2004	17		HYRE

Breeding Year	LocationID	Date	Egg Masses	Egg Mass Categories	SpeciesID
2005	LS05	1/14/2005	11		HYRE
2005	LS05	2/2/2005	26		HYRE
2005	LS05	2/2/2005	3		RADR
2005	LS05	3/1/2005	2		HYRE
2005	LS05	3/30/2005	10		HYRE
2006	LS05	1/6/2006	6		RADR
2006	LS05	1/25/2006	3		HYRE
2006	LS05	1/25/2006	3		RADR
2006	LS05	2/16/2006	2		HYRE
2005	LS06	2/2/2005	2		HYRE
2005	LS06	3/1/2005	1		HYRE
2006	LS06	1/6/2006	4		HYRE
2006	LS06	1/25/2006	9		HYRE
2006	LS06	1/25/2006	3		RADR
2006	LS06	2/16/2006	3		HYRE
2006	LS06	3/20/2006	9		HYRE
2006	LS07	1/6/2006	15		HYRE
2006	LS07	1/25/2006	2		HYRE
2006	LS07	3/20/2006		2	HYRE
2004	MC01	1/16/2004	39		RADR
2004	MC01	1/16/2004		5	HYRE
2004	MC01	2/6/2004		1	HYRE
2004	MC01	3/3/2004	1		RADR
2004	MC01	3/3/2004		3	HYRE
2004	MC01	3/30/2004	3		HYRE
2005	MC01	12/20/2004	3		HYRE
2005	MC01	12/20/2004	7		RADR
2005	MC01	1/14/2005	10		RADR
2005	MC01	1/14/2005		2	HYRE
2005	MC01	2/2/2005	18		RADR
2005	MC01	2/2/2005		2	HYRE
2005	MC01	2/23/2005	4		RADR
2006	MC01	1/6/2006	20		RADR
2006	MC01	1/25/2006	10		RADR
2006	MC01	2/16/2006	1		RADR
2006	MC01	2/16/2006		2	HYRE
2005	RC01	1/6/2005	1		HYRE
2006	RC01	1/25/2005	2		HYRE
2004	RC02	1/20/2004	4		HYRE
2004	RC02	3/3/2004	9		HYRE
2004	RC02	3/3/2004	4		TAGR
2004	RC02	3/17/2004	4		HYRE
2004	RC02	3/17/2004	12		TAGR
2004	RC02	4/2/2004	9		TATO
2005	RC02	1/6/2005	1		HYRE
2005	RC02	3/17/2005	2		HYRE
2005	RC02	3/17/2005	2		TATO
2005	RC03	1/6/2005	3		HYRE

Breeding Year	LocationID	Date	Egg Masses	Egg Mass Categories	SpeciesID
2005	RL02	1/12/2005	1		RADR
2005	RL02	1/28/2005	2		RADR
2005	RL02	3/9/2005	1		RADR
2006	RL02	1/5/2006	1		RADR

KEY: HYRE: *Hyla regilla*, RADR: *Rana draytonii*, TAGR: *Taricha granulosa*, TATO: *Taricha torosa*

Table 6: Summary of trapping data for 2003-2005

Location	UTM N	UTM E	Survey Date (mm/dd/yyyy)	Trap Type (number of traps)	Species	Life Stage	Count of Species	Notes
Rodeo Lake Site 1	4187240	541783	6/28/2005	Minnow trap (2)	STK		8	Trap Duration: 0800-1600 PST
					TAGR	Adult	1	
					RADR	tadpole	10	
Rodeo Lake Site 2	4187246	541822	6/28/2005	Minnow trap (2)	STK		10	
					RADR	tadpole	1	
Rodeo Lake Site 3	4187253	541837	6/28/2005	Minnow trap (2)	STK		4	
Big Lagoon Environs @ Green Gulch weir	4190482	537468	7/1/2005	Minnow trap (3)	TAGR	Adult	10	Trap Duration: 1200-1540 PST
					TAGR	Larvae	1	
					TATO	Larvae	2	
					STK		Approx. 75	
Pine Gulch Mainstem	4197181	526162	4/26/2004	Smolt Trap (1)	RADR	tadpole	1	72 mm
Olema Creek Mainstem	4212461	517111	5/1/2005	Smolt Trap (1)	RADR	tadpole	1	45 mm
				Smolt Trap (1)	RADR	tadpole	1	52 mm
				Smolt Trap (1)	RADR	tadpole	1	54 mm
				Smolt Trap (1)	RADR	tadpole	1	54 mm
				Smolt Trap (1)	RADR	tadpole	1	39 mm
				Smolt Trap (1)	RADR	tadpole	1	61 mm
				Smolt Trap (1)	RADR	tadpole	1	60 mm
				Smolt Trap (1)	RADR	tadpole	10	2 were dead
			5/2/2005	Smolt Trap (1)	RADR	tadpole	31	
			5/3/2005	Smolt Trap (1)	RADR	tadpole	21	2 were dead
			5/4/2005	Smolt Trap (1)	RADR	tadpole	19	3 were dead
			5/6/2005	Smolt Trap (1)	RADR	tadpole	30	21 were dead
			5/7/2005	Smolt Trap (1)	RADR	tadpole	22	1 was dead
			5/8/2005	Smolt Trap (1)	RADR	tadpole	42	

KEY: HYRE: *Hyla regilla*, RADR: *Rana draytonii*, STK: *Gasterosteus aculeatus*, TAGR: *Taricha granulosa*, TATO: *Taricha torosa*

Table 7: Duration of ponding for California red-legged frog breeding sites

Location	Calendar Year	Date Site Became Dry
Big Lagoon	2003	Early summer
	2004	Sometime between May-Sept 2004
	2005	August 30, 2005 (Site RC01)
Rodeo Lake	2004	Perennial
	2005	Perennial
Milagra Ridge	2003	August 20, 2003
	2004	
	2005	
Mori Point	2003	N.A.
	2004	N.A.
	2005	Pond A perennial, Pond D Jul 23, 2005

Table 8: Mean monthly salinity levels at eastern Rodeo Lagoon from December through March, 2003-2005*

Location	Date	n	Mean Salinity (Std. Dev)
East Rodeo Lagoon	Winter 2003-04	3	0.1 (0.1)
	Winter 2004-05	4	0.3 (0.3)
	Winter 2005-06	2	0.3 (0.1)

*Data collected using surface grab samples and analysis by refractometer. Data courtesy of Erik Kellner, Headlands Institute

FIGURES

Figure 1: Location of stranded California red-legged egg masses at Horse Stable Pond, February 11, 2005 (Photo courtesy of Jon Campo)

Figure 2: A stranded California red-legged egg mass along shoreline of Horse Stable Pond, February 11, 2005 (Photo courtesy of Jon Campo)

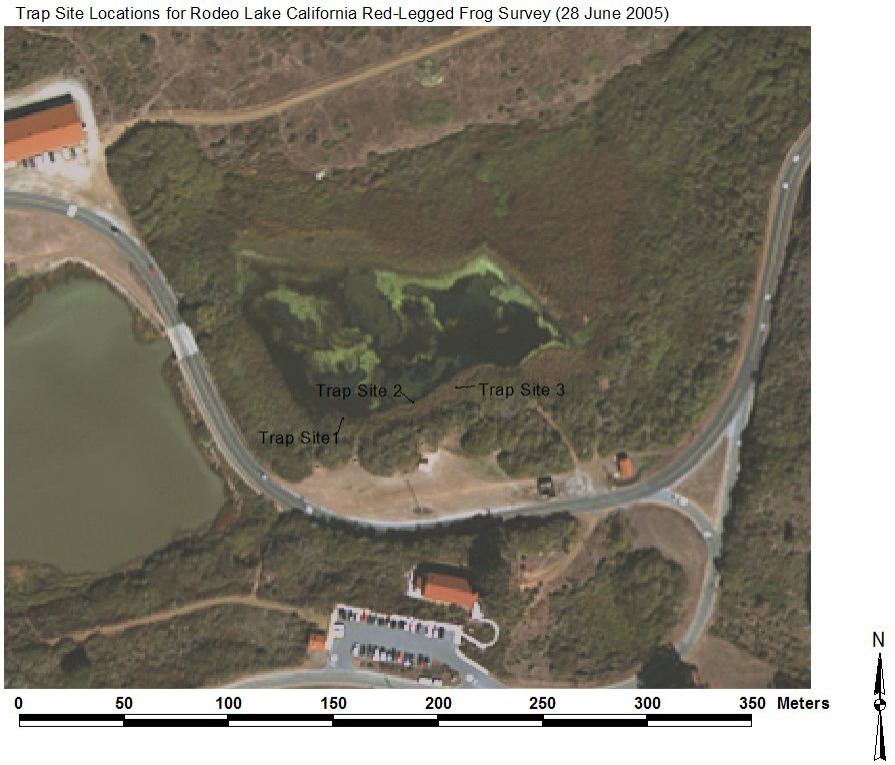

Figure 3: Location of minnow traps along Rodeo Lake, Marin County

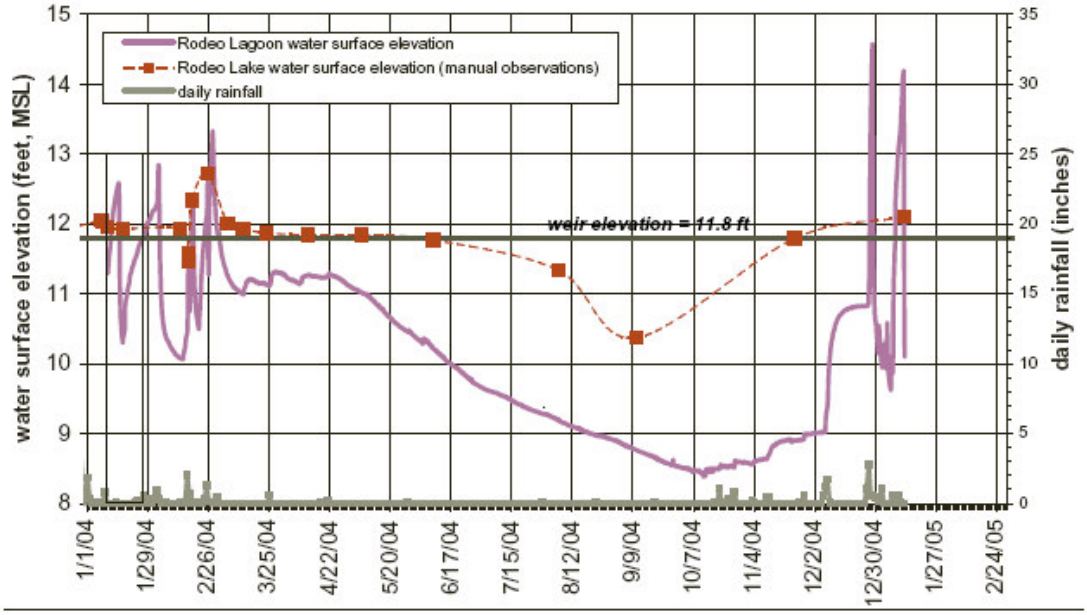

Figure 7. Water level in Rodeo Lagoon at Bunker Road. Several periods of lagoon overtopping are evident during the winters, occurring both during storms and several days after storms. During the spring, outflow by seepage through the beach is approximately equal to inflow from tributaries. As flow from the watershed recedes during the summer, lagoon water levels decline by as much as 4 feet until rainfall begins again. In the fall and early winter, Rodeo Lake water levels rise in response to increasing rainfall, but it is not until Rodeo Lake overtops the weir that substantial water level increases and lagoon overtopping is able to take place.

Figure 4: Water levels at Rodeo Lake and Lagoon, 2004-2005 (from Shaw 2005)

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APPENDIX I: DESCRIPTION OF SURVEY SITES

Big Lagoon Environs (Marin Co.). The Redwood Creek watershed is a coastal drainage in southern Marin County, California. It covers 7.5 square miles (PWA *et al*. 1994). Before discharging into the ocean, Redwood Creek joins with its last tributary, Green Gulch, to form Big Lagoon, an intermittent tidal lagoon approximately 2.2 acres, and associated backwater areas. Barring uncharacteristic hydrologic events, Big Lagoon is connected to the Pacific Ocean during winter and spring months and closed during the remainder of the year.

Historically, Big Lagoon was a 30-acre wetland complex consisting of a freshwater lagoon, seasonal wetlands, dunes, and an intermittently tidal lagoon (PWA *et al*., 1994). The historic wetlands were likely characterized by emergent vegetation such as sedges, tules, and cattails along the periphery and open water habitats. This historic habitat was degraded through channelization, levee construction, filling, dune removal, and accelerated sedimentation (PWA *et al*., 1994). Currently, the historic wetland is overlain by the Muir Beach Parking Lot, picnic facilities, and an abandoned horse pasture. This pasture is flooded during the winter and spring by runoff from Green Gulch Creek. Extensive emergent vegetation dominated mainly by cattails is present. Small areas of open water bordered by emergent vegetation are found along drainage ditches. The first documented breeding activity at Big Lagoon was during the Winter 1996-1997 where lone red-legged frog egg mass was encountered. Subsequent breeding surveys by USGS and contractors have identified egg masses, adult, and juvenile California red-legged frogs (Fellers and Guscio 2004, Wood 2005). Routine egg mass surveys have been conducted since Winter 1996-1997.

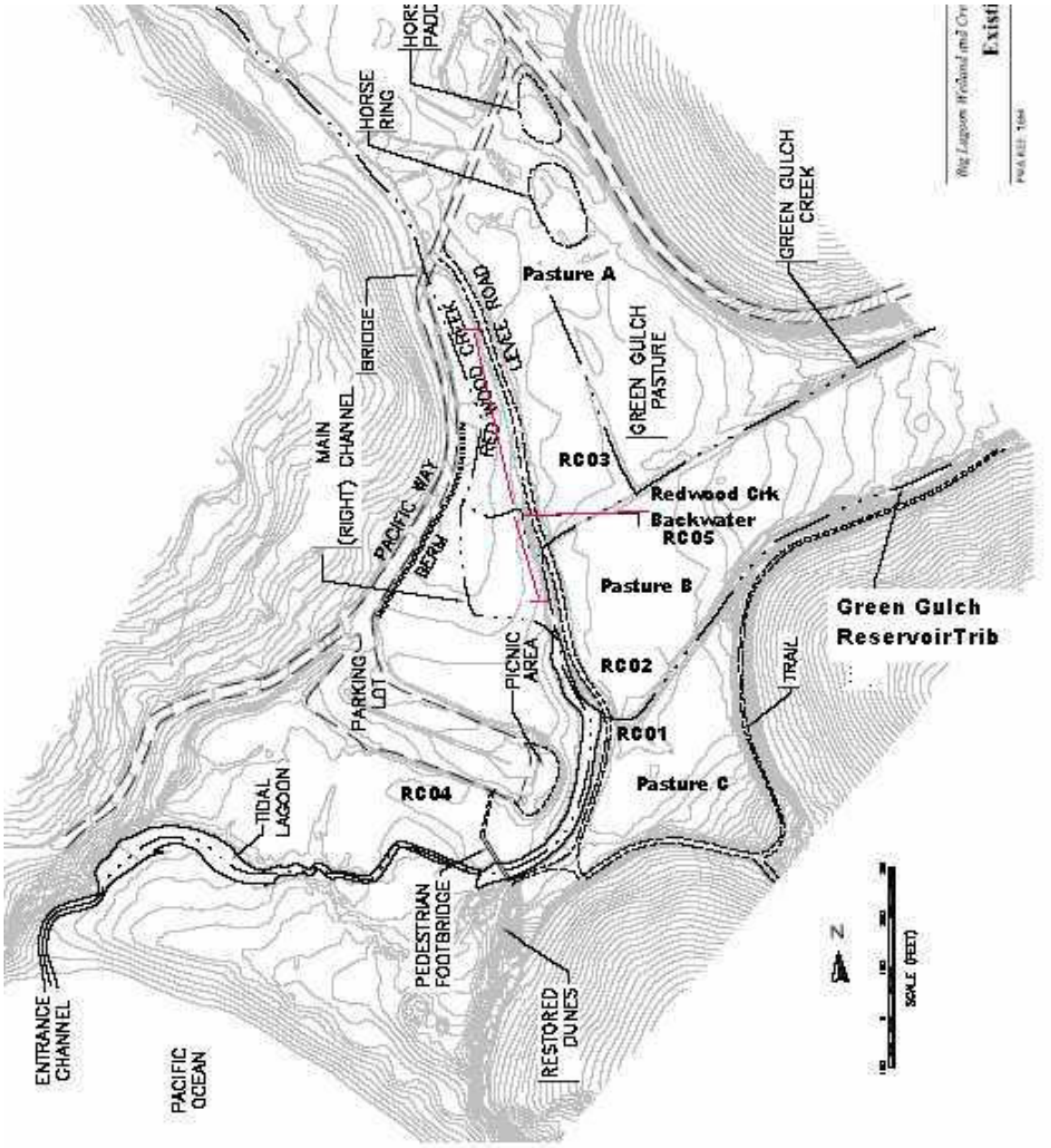

Figure 5: Survey Locales for Big Lagoon Environs, GOGA, Marin Co.

Figure 6: Typical Winter Conditions at Big Lagoon Pasture A Cross Ditch, February 25, 2005

Figure 7: Typical Winter Conditions at Big Lagoon Pasture B (including USGS P-143B) from Levee, February 25, 2005

Figure 8: Typical Winter Conditions at Big Lagoon Pasture C (including USGS P-143A) from Levee, February 25, 2005

Rodeo Lake/Lagoon (Marin Co.): The Rodeo Lagoon watershed is a small coastal watershed (3.6 sq. miles) that drains to the Pacific Ocean. Rodeo Lagoon is presently a 16.2 ha (40 acre) brackish water lagoon located at the tip of the Marin Peninsula within the management area of the Golden Gate National Recreation Area. Water depths are shallow, ranging between 2-6 feet during the late fall. A narrow band of emergent wetland vegetation encircles the lagoon. Submergent vegetation is dominated by *Potamogeton* sp., although frequent algal blooms within the Lagoon may suppress the extent of submergent vegetation. Frog surveys have focused on the east end of the lagoon due to the greater freshwater influence.

Just upstream of the lagoon, Rodeo Lake covers 5.5 acres of open water and emergent and mats of submergent vegetation. Construction of a causeway and weir across the upper end of the lagoon during World War II separated the lagoon into a predominantly freshwater lake (Rodeo Lake) and the existing brackish water lagoon. This hydrologic separation likely restricts upstream movement of swimming organisms from the lagoon. Poor water quality conditions may be present during the late summer. Measurements found dissolved oxygen levels of 0.7 mg/l at the lake bottom during an algal bloom.

Rodeo Lake supports mostly non-native fish including green sunfish (*Lepomis cyanellus*), goldfish (*Carassius auratus*), and golden shiner (*Notemigonus crysoleucas*). Sedimentation and encroachment of emergent and willow riparian vegetation around the lake has reduced the amount of open water area. During the summer, the remaining open water is often filled with an introduced aquatic plant, coontail (*Myriophyllum* sp.). Mats of submergent vegetation composed mainly of *Hydrocotyle* sp. ring the open water areas of the lake year-round.

Figure 9: Typical Winter Conditions along South Rodeo Lake Shoreline Looking West, February 8, 2005 (concentric bands of willow, cattail, and *Hydrocotyle*)

Milagra Ridge (San Mateo Co.). The site is located in an area that historically supported both California red-legged frogs and San Francisco garter snakes (Sean Barry, pers. comm. 1999). However, almost all of the natural habitats, such as the seismic sag ponds near the current Skyline Boulevard were destroyed during the 1950's and early 1960's by housing and urban development (Banta and Morafka 1966; Barry, 1978, 1993, 1994).

The survey site is located at an abandoned military oxidation pond shown on construction drawings from our Park archives to have been built prior to 1969 (U.S. Army 1969). The site covers 0.17 acres and is seasonally ponded with water. Because the pond sits atop a knoll, it is believed that there is little surface water runoff contribution and probably no groundwater contribution. The Park modified a concrete drop inlet structure that controls water surface elevation to prolong ponding of water. In 1999, a staff gage was installed to record the height and duration of ponded water. The pond contains relatively shallow nearshore areas that during the winter contain submerged aquatic vegetation, submerged annual grasses, and *Juncus*. In addition, about a half of the site contains cattails and bulrushes.

Initial surveys for California red-legged frogs occurred in 1999 after Nancy Hornor, the Park planner, received a report of a dead red-legged frog along an adjacent road. Routine egg mass surveys have been conducted since Winter 1998-1999.

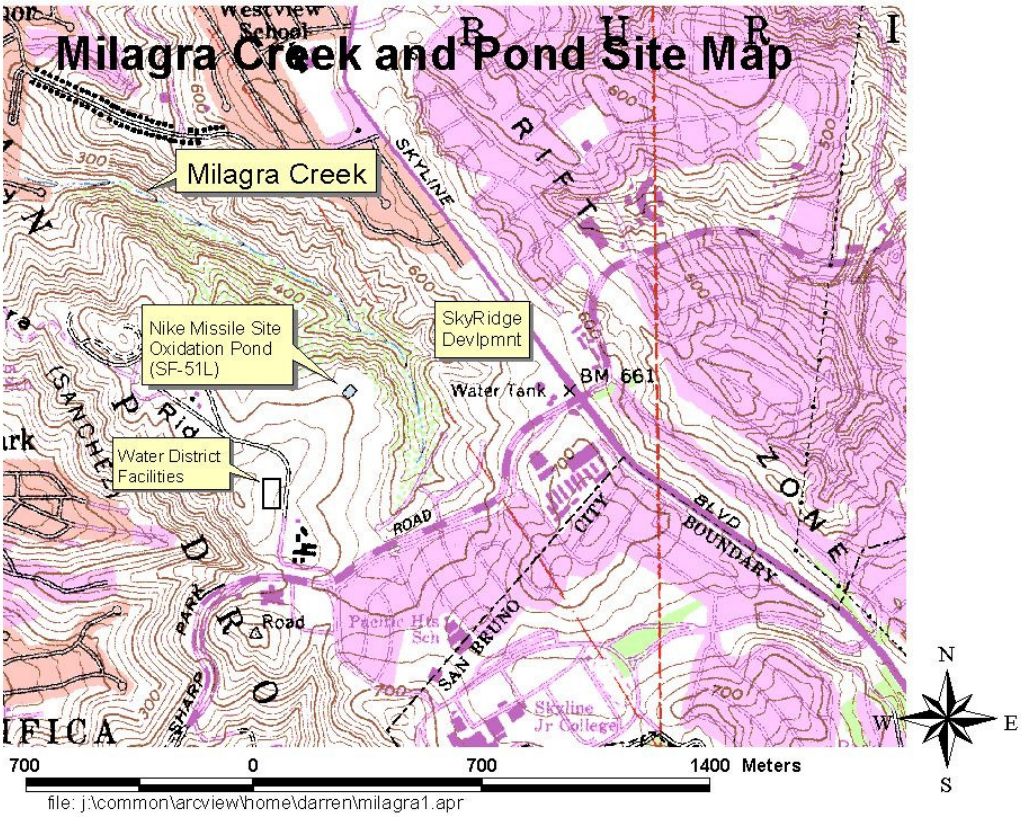

Figure 10: Milagra Ridge Oxidation Pond, GOGA, San Mateo Co.

Figure 11: Typical Winter Conditions at Milagra Pond, Jan 16, 2004.

Sharp Park/Mori Point (San Mateo Co.)**.** Sharp Park Golf Course and Mori Point are two contiguous sites is within the Sanchez Creek watershed area which covers 844 acres (1.3 sq. miles) (PWA et al., 1992). This area includes several wetland features (Laguna Salada, Horse Stable Pond, Sanchez Creek) that have been documented by a variety of studies to contain both California red-legged frogs and San Francisco garter snakes. The City and County of San Francisco manages the golf course and natural areas on the site including Laguna Salada and Horse Stable Pond. Interest in protecting and restoring natural resources on the site has led to the development of a restoration plan (PWA 1992).

Originally part of the Spanish San Pedro Land Grant, Mori Point has been the site of many enterprises over the past 120 years. The Mori family originally farmed the area in the 1890's and from 1920-1950's was the site of the Mori Point Tavern. Part of Mori Point has also been used as a rock quarry and signs of this former use are evident on the hillsides. In 2000, the 105-acre parcel was added to the GGNRA. In November 2004, USFWS, Golden Gate National Park Conservancy and GGNRA completed the construction of two seasonal ponds at Mori Point to provide for amphibian use and foraging opportunities for the San Francisco garter snake.

Along the east side of Laguna Salada, vegetation is relatively wide and continuous comprised mainly of tules and cattails. Along the west side, vegetation is more sparse with open coves containing low saltgrass and Monterey cypresses. The watershed is a mixture of urban uses such as residences, roads and golf course while open space areas such as Sweeney Ridge are under management of GGNRA. Stormwater runoff as well as water from the City's Hetch Hetchy reservoir (used as irrigation water for golf course) flows into Sanchez creek and is pumped out and discharged to the ocean at Horse Stable Pond (PWA *et al.,* 1992). Pumps are typically operated during winter months although protective measures have been enacted during the Winter 2005-2006 to prevent eggs from becoming stranded before they hatch.

Egg mass surveys for California red-legged frogs started in 1999 at Laguna Salada and at Mori Point in 2004.

Figure 12: Sampling Locales for Sharp Park/Mori Point, GOGA and City of San Francisco, San Mateo Co.

Figure 13: Discharge of Sanchez Creek/Horse Stable Pond to the Pacific Ocean, Jan 16, 2004.

Figure 14: Typical Winter Conditions at Seasonal Mori “Bowl” Wetlands, January 16, 2004

Figure 15: Typical Winter Conditions at Created Wetland Adjacent to Sanchez Creek, Pond A, December 15, 2004